# A Synthesis of the ADDIE Model and Pustekkom: Development of the "SAHAT" Interactive Multimedia Tool for Christian Religious Education in Elementary Schools

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## Abstract

Christian Religious Education (CRE) in elementary schools faces a persistent challenge: abstract theological content clashes with *Third* graders' need for concrete, visual, and manipulable learning. This study developed and evaluated the validity, practicality, and potential learning effects of an interactive multimedia product based on the SAHAT Model, merging ADDIE's systems orientation, the Pustekkom production model, and a concrete-to-symbolic learning approach across five stages: Preliminary Study, Analysis, Harmonization, Application, and Finalization. The product was developed at State Elementary School 41 in Gorontalo City during the 2021/2022 academic year. The preliminary study involved three schools, while formative evaluation comprised expert review, one-to-one and small-group testing (three pupils each), and a field test with 20 *Third* graders. Data were gathered through observation, documentation, and pretest-posttest instruments, then analyzed descriptively. Expert review and revision confirmed the product's feasibility; practicality reached 80.67% in the one-to-one evaluation, 80.00% in the small-group evaluation, and 84% in the field test. Because the design lacked a comparison group and posttest items were embedded in the product, gains are reported as within-group mastery change rather than a causal effect: mastery rose from 25% to 100%, with 19 of 20 pupils (95%) scoring above the minimum mastery criterion and one meeting it exactly. These results suggest that the product's value lies not merely in adding media but in harmonizing objectives, learner characteristics, religious content, navigation, and formative evaluation. Further usability and controlled-design studies are needed to confirm applicability and effectiveness.

**Keywords:** interactive multimedia; SAHAT Model; Christian Religious Education; formative evaluation; cognitive theory of multimedia learning.

## Introduction

Religious education at the elementary level does more than transmit declarative knowledge about teachings, figures, or sacred texts. It ties conceptual understanding to gratitude, care, habit, and everyday action. Many religious concepts, however, such as God's omnipotence, the creation and preservation of the universe, and human diversity, cannot be directly observed. *Third*-grade students still depend on concrete experience, visual examples, ordered sequences, repetition, and immediate feedback. When abstract content reaches them only through lectures and written text, the gap between the intended message and the experience they can construct from it grows. Students then repeat religious terms without forming coherent mental representations.[1]

The preliminary study for this research showed the same pattern. In three elementary schools in Gorontalo City, Christian Religious Education (CRE) instruction was dominated by lectures, question-and-answer sessions, textbooks, and static images. Films, projectors, and digital devices appeared only occasionally, even in schools with internet hotspots and computer laboratories. The constraint was not the absence of technology but the absence of instructional design that could turn it into interactive learning. At SD Negeri 41 Kota Gorontalo, instruction was uniform, unchallenging, and prone to boredom; on the assessment conducted before the product was introduced, only 25% of students reached the required mastery level. Access to technology, in short, does not by itself produce pedagogical quality.

The local findings align with a broader shift in educational technology research. Studies no longer ask whether technology beats conventional instruction in general, but under what conditions, for whom, for which content, and through what design it supports learning. A meta-analysis of disadvantaged learners reported a positive overall effect, yet computer-assisted instruction and behavioral support outperformed the mere provision of devices.[2] A systematic review of elementary classrooms found that interactive media, most often multimedia, tended to raise motivation and outcomes. Still, the effect

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[1] J Piaget, "Piaget's Theory of Cognitive Development," in *Childhood Cognitive Development: The Essential Readings*, vol. 2, 2000, 33–47.

[2] G Di Pietro and J Castaño Muñoz, "A Meta-Analysis on the Effect of Technology on the Achievement of Less Advantaged Students," *Computers & Education* 226 (2025): 105197, https://doi.org/10.1016/j.compedu.2024.105197.

depended on teacher competence, material fit, and design quality.[3] Reviews of multimedia tools across the teaching–learning cycle report positive but heterogeneous effects that are shaped by how the tools are designed and used, not by their mere adoption.[4] "Using technology" is too broad a label to explain any learning mechanism. What matters is how text, images, audio, video, animation, tasks, navigation, and feedback combine to form a single instructional system.

The conceptual basis for multimedia learning lies in the architecture of the mind. The Cognitive Theory of Multimedia Learning holds that verbal and visual information travel through separate channels of limited capacity, and that meaningful learning requires learners to select, organize, and integrate new information with prior knowledge.[5] Adding more media does not, therefore, mean better multimedia. Long text passages, simultaneous narration, decorative animation, irrelevant music, and confusing navigation all raise extraneous cognitive load. Signaling, spatial contiguity between text and image, segmentation, coherence, personalization, and learner control over sequence, by contrast, help students build stronger mental models.[6] The meta-meta-analysis by Noetel et al. (29 reviews, 1,189 studies, 78,177 participants) found consistent positive effects for signaling, contiguity, segmenting, and coherence.[7] Even so, these principles do not transfer uniformly: their behavior depends on the learning environment and the learner population.[8]

A recent meta-analysis of Mayer's own multimedia corpus reported a moderate overall effect ($g = 0.37$), with the magnitude shaped by age, knowledge domain, media

[3] W N Aryfien, I R W Atmojo, and Matsuri, "Interactive Learning Media for Better Learning Outcomes in Elementary School: A Systematic Literature Review," *Mimbar Sekolah Dasar* 12, no. 1 (2025): 132–47.
[4] M D Abdulrahaman et al., "Multimedia Tools in the Teaching and Learning Processes: A Systematic Review," *Heliyon* 6, no. 11 (2020): e05312, https://doi.org/10.1016/j.heliyon.2020.e05312.
[5] R E Mayer, "The Past, Present, and Future of the Cognitive Theory of Multimedia Learning," *Educational Psychology Review* 36, no. 1 (2024), https://doi.org/10.1007/s10648-023-09842-1.
[6] J C Castro-Alonso et al., "Five Strategies for Optimizing Instructional Materials: Instructor- and Learner-Managed Cognitive Load," *Educational Psychology Review* 33, no. 4 (2021): 1379–1407, https://doi.org/10.1007/s10648-021-09606-9; M Noetel et al., "Multimedia Design for Learning: An Overview of Reviews With Meta-Meta-Analysis," *Review of Educational Research* 92, no. 3 (2022): 413–54, https://doi.org/10.3102/00346543211052329.
[7] Noetel et al., "Multimedia Design for Learning: An Overview of Reviews With Meta-Meta-Analysis."
[8] B Çeken and N Taşkın, "Multimedia Learning Principles in Different Learning Environments: A Systematic Review," *Smart Learning Environments* 9, no. 1 (2022), https://doi.org/10.1186/s40561-022-00200-2.

type, learning outcome, duration, and the specific design principles applied.[9] The largest effects came not from changes in visual presentation but from interventions that activated learning, self-explanation, testing, scaffolding, and cueing. This has direct implications for CRE. Videos about creation, images of nature, or audio stories do little if students remain passive. Effective media let students choose from menus, predict sequences, answer questions, receive corrective feedback, revisit sections, and link content to acts of care for creation. Interactivity is cognitive and pedagogical work, not clickable buttons.

Dynamic, participatory design carries additional weight in religious education. Aseery reports that motivation and engagement in elementary religious classes grow through digital storytelling, animation, audio, film dialogue, practical application, positive feedback, and task chunking.[10] These strategies connect religious content to students' experience without thinning its meaning. Technology remains a mediator, not a replacement for the teacher: teachers interpret the digital experience, tie stories to values, guide questions, and prevent visual representations from oversimplifying theological content.

Several development studies have produced interactive multimedia that were judged valid and well-received. The ADDIE model is widely used for its systematic sequence and communicative clarity.[11] Work on multimedia for the human circulatory system, together with studies of interactive instructional technology, stresses alignment among content, activities, and interface.[12] Interactive multimedia e-modules are associated with better outcomes and positive responses in elementary classrooms,[13] and

[9] J G Cromley and R Chen, "A Meta-Analysis of Richard Mayer's Multimedia Learning Research: Searching for Boundary Conditions of Design Principles across Multiple Media Types," *Educational Research Review* 49 (2025): 100730, https://doi.org/10.1016/j.edurev.2025.100730.
[10] A Aseery, "Enhancing Learners' Motivation and Engagement in Elementary Religious Education Classes," *British Journal of Religious Education* 46, no. 1 (2024): 43–58, https://doi.org/10.1080/01416200.2023.2256487.
[11] F Daryanes et al., "The Development of an Articulate Storyline and Interactive Learning Media Based on Case Methods to Train Students' Problem-Solving Ability," *Heliyon* 9, no. 4 (2023): e15082, https://doi.org/10.1016/j.heliyon.2023.e15082.
[12] I Munawaroh, S Sulthoni, and S Susilaningsih, "Development of Interactive Multimedia on the Human Circulatory System for 5th-Grade Elementary School Students," *JKTP: Jurnal Kajian Teknologi Pendidikan* 5, no. 2 (2022): 190–99, https://doi.org/10.17977/um038v5i22022p190; F Tuma, "The Use of Educational Technology for Interactive Teaching in Lectures," *Annals of Medicine and Surgery* 62 (2021): 231–35, https://doi.org/10.1016/j.amsu.2021.01.051.
[13] R Alyusfitri et al., "The Effectiveness and Relationship of Student Responses toward Learning Outcomes Using Interactive Multimedia-Based e-Modules in Elementary Schools," *International Electronic Journal of Elementary Education* 16, no. 5 (2024): 573–84, https://doi.org/10.26822/iejee.2024.354.

interactive visual multimedia has improved literacy among elementary children in resource-limited settings.[14]

Four gaps remain. *First*, many development studies end at expert validation or user feedback without linking design decisions to pre- and post-intervention performance, a known weakness of under-supported design research.[15] *Second*, general development models describe stages at a macro level but rarely provide novice teachers with the operational guidance needed to translate competencies, content, learner characteristics, technology, scripts, production, and evaluation into concrete steps. *Third*, and most specific to this study, elementary multimedia development has concentrated on STEM, language, and literacy, and the available syntheses remain weighted toward higher education.[16] Multimedia designed for CRE, with its abstract content and value- and attitude-oriented aims, remains scarce; the size of this gap still requires quantification through a systematic database search. Fourth, instructional design models and media production models are rarely compared head-to-head. Each sets a different priority: system logic in Dick and Carey; sequencing of complex skills in van Merriënboer and Kirschner's 4C/ID; production workflow in Alessi and Trollip, and in Lee and Owens.[17] What an integrated model would add, therefore, remains unclear. This study positions the SAHAT Model as an alternative to these models, not a claim to uniqueness in isolation.

SAHAT, an acronym derived from Preliminary Study, Analysis, Harmonization, Application, and Establish (Preliminary Study, Analysis, Harmonization, Application, Finalization), addresses these gaps. The model adds no new stage beyond ADDIE; its contribution is procedural. The Harmonization stage converts what ADDIE calls the Design phase into a small set of mandatory, reviewable artifacts: an objective-to-content map, a cognitive flowchart, a storyboard, and an electronic script. These artifacts connect competencies, core content, learner development, the school's technological capacity,

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[14] H Dong et al., "The Effectiveness of Using Interactive Visual Multimedia Technology Intervention in Improving the Literacy Skills of Children in Rural China," *Learning and Motivation* 86 (2024): 101964, https://doi.org/10.1016/j.lmot.2024.101964.
[15] S McKenney and T C Reeves, *Conducting Educational Design Research*, 2nd ed. (Routledge, 2018); T C Reeves, "Design Research from a Technology Perspective," in *Educational Design Research*, ed. J van den Akker et al. (Routledge, 2006), 52–66.
[16] E Staneviciene and G Žekienė, "The Use of Multimedia in the Teaching and Learning Process of Higher Education: A Systematic Review," *Sustainability* 17, no. 19 (2025): 8859, https://doi.org/10.3390/su17198859.
[17] W Dick, L Carey, and J O Carey, *The Systematic Design of Instruction*, 8th ed. (Pearson, 2015).

screen flow, and evaluation before production begins. Harmonization functions as a quality gate that non-designer teachers can, in principle, follow, not as a conceptual novelty. The model also joins ADDIE's systems orientation to the Pustekkom media-production orientation, and it orders learning experiences from concrete to symbolic. Whether the resulting five-stage, nine-step sequence is easier for teachers to apply than existing models is an empirical question this feasibility study does not answer.

The study contributes on three levels. Theoretically, it shows how multimedia principles apply to abstract religious content for learners at the concrete-operational stage. Methodologically, it proposes a formative evaluation sequence: expert review, one-to-one evaluation, small-group evaluation, and field testing. Practically, it produces a multimedia product that runs on desktops, laptops, tablets, or smartphones, both online and offline. The study also separates "potential effect" from causal claim: a large gain in mastery is a promising early signal, but it does not remove the need for comparison groups, retention measures, and inferential analysis.

The study therefore aims to (1) develop an interactive multimedia design for Christian Religious Education using the SAHAT Model; (2) establish the product's feasibility through validation and formative evaluation; (3) describe its practicality in student use; and (4) identify its potential effect on learning outcomes. The article separates results from discussion so that the development data can *first* be read on their own terms and then interpreted against current theory and evidence.

**Research Method**

This study used a research and development (R&D) approach to build and evaluate an interactive multimedia design for Christian Religious Education (CRE). The process centered on product development rather than on causal theory testing and progressed through needs analysis, design, production, formative evaluation, revision, and field testing. The study was conducted at SD Negeri 41 Kota Gorontalo during the second semester of the 2021/2022 academic year. We selected this school for four reasons: it enrolled Christian students, employed a CRE teacher, operated an internet hotspot, and maintained a computer laboratory, a combination that let us examine pedagogical need and technological readiness at the same site.

Research permission was granted by the Gorontalo City One-Stop Integrated Services Office (Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu, DPMPTSP), recommendation letter No. 503/DPMPTSP/RIP/385/VI/2022 (8 June 2022), which designated SD Negeri 41 Kota Gorontalo as the research site. The school principal issued site authorization through letter No. 422/SDN-41/HL-TG/129/VII/2022 (11 July 2022). Because the participants were third-grade children, parental informed consent was obtained orally through the CRE teacher, who also facilitated child assent before each session. Oral rather than written parental consent and reliance on institutional permissions rather than a formal ethics committee (IRB) review are limitations relative to current international reporting standards. Future studies at this site should obtain IRB approval, written parental consent, and documented child assent.

The preliminary study was conducted on 18 November 2021 at the three schools that together account for most CRE provision in the city: SD Perguruan Yayasan Maesa, a Protestant school affiliated with the Indonesian Protestant Church in Gorontalo (Gereja Protestan Indonesia di Gorontalo, GPIG); a Roman Catholic elementary school under the Catholic Education Foundation (Yayasan Pendidikan Katolik); and SD Negeri 41 Kota Gorontalo, a state school. Data collection combined observations, interviews, and questionnaires. At this stage, we mapped instructional practice, student characteristics, teacher availability, learning resources, internet access, and available digital devices.

Product development and field testing were then focused on SD Negeri 41 Kota Gorontalo. Field-test participants were 20 third-grade students. The one-to-one evaluation involved three students selected to represent high, moderate, and low ability; the small-group evaluation involved three students working simultaneously; the field test involved all 20 students. The sequence follows the logic of formative evaluation, which surfaces design problems progressively from single users to the full classroom.[18] One caveat applies: both the one-to-one and small-group stages used a micro-sample of three pupils, below Tessmer's recommended range of 8–20 for the small-group stage.[19] The small-group evaluation should therefore be read as a simultaneous-use check rather than a fully powered group evaluation, and we treat it as such throughout.

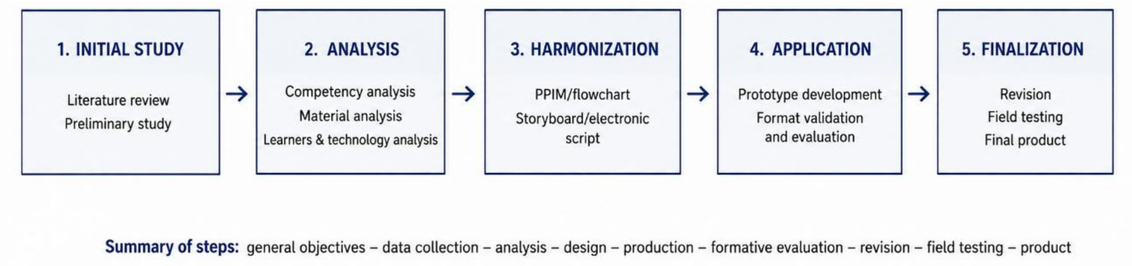
[18] M Tessmer, *Planning and Conducting Formative Evaluations: Improving the Quality of Education and Training* (Kogan Page, 1993).
[19] Tessmer, *Planning and Conducting Formative Evaluations: Improving the Quality of Education and Training*.

The development model combines ADDIE and the Pustekkom media-production model.[20] ADDIE contributes a systemic framework of analysis, design, development, implementation, and evaluation; Pustekkom contributes the production stages of design, production, and evaluation. Integrating the two yielded the SAHAT Model, five stages and nine steps. Table 1 and Figure 1 show its structure.

Table 1.
Stages and Operational Steps of the SAHAT Model

| **Stage** | **Step** | **Main Activities** | **Outputs** |
|---|---|---|---|
| Preliminary Study | 1–2 | Establishing general objectives through a literature review and collecting data through an exploratory study. | A map of problems, needs, general objectives, and the school context. |
| Analysis | 3 | Analyzing competencies and content, student characteristics, and information and technology systems. | Pedagogical, content, user, and device specifications. |
| Harmonization | 4 | Developing the main content points or flowchart and the storyboard or electronic script. | A blueprint aligning content, visuals, audio, navigation, and evaluation. |
| Application | 5–6 | Producing the initial draft and conducting expert validation, one-to-one evaluation, and small-group evaluation. | Prototypes 1 and 2, together with a list of formative revisions. |
| Finalization | 7–9 | Conducting revisions, field testing, and final product refinement. | Prototype 3 and the final interactive multimedia product. |

Figure 1.
Development Flow of the SAHAT Model: Five Stages and Nine Steps




The product delivered third-grade lessons on God's omnipotence and the creation of the universe, human diversity, biblical stories, gratitude, and care for the environment. Content was presented through text, images, audio, instrumental music, video, animation, interactive menus, user instructions, exercises, and multiple-choice questions. The product ran on computers, laptops, tablets, and smartphones, and connected to YouTube,

[20] Robert Maribe Branch and İlhan Varank, *Instructional Design: The ADDIE Approach*, vol. 722 (Springer, 2009); B Warsita, *Teknologi Pembelajaran: Landasan Dan Aplikasinya* (Rineka Cipta, 2008).

Google Drive, Google Forms, and Google Classroom. It also worked offline, so learning did not require a live internet connection.

A panel of experts evaluated the product's feasibility across six dimensions: accuracy of the competencies and content, instructional structure, visual quality, language appropriateness, navigational clarity, and readiness for further testing. Their recommendations guided revisions before user evaluation. In the one-to-one evaluation, students used the product individually so we could identify navigational difficulties, readability problems, comprehension of instructions, and initial responses to the material. In the small-group evaluation, three students used the prototype together so we could examine ease of use, interaction, and learning outcomes. After further revision, we tested the *Third* prototype with 20 students in a field trial.

We collected data through observation, documentation, and testing. The observation sheet contained eight indicators of user behavior: attention to instructions; asking questions; interest in participating; enthusiasm and motivation; ease of understanding; task completion; interaction with the media; and expression of opinions. Each descriptor was scored 1 when observed and 0 when not, and the scores were converted to percentages. Practicality categories were highly practical (86–100%), practical (71–85%), moderately practical (56–70%), impractical (41–55%), and highly impractical (20–40%), with cut-offs adapted from Riduwan and Akbar, documentation covered the product itself, revision records, observation results, and students' scores.[21]

The 80.67%–84% practicality figures carry three qualifications tied to the observation procedure. *First*, a single researcher conducted all observations. With only one rater, we could not compute an inter-rater agreement statistic; adding a *Second* coder on a subset of sessions is a priority for future administrations. As a stability check, we applied the same protocol across successive prototypes under revised conditions (one-to-one prototype, 80.67%; field-test prototype, 84%), but this is consistency across iterations, not an inter-rater metric. *Second*, expert review confirmed the content validity of the eight-indicator sheet. *Third*, we assessed each indicator at the group level: the denominator was the class or group, not individual students. The practicality percentages

[21] Riduwan, *Skala Pengukuran Variabel-Variabel Penelitian* (Alfabeta, 2013); S Akbar, *Instrumen Perangkat Pembelajaran* (Remaja Rosdakarya, 2013).

should therefore be read as descriptive indicators, not psychometrically established measures.

During the field trial we administered a pretest and a posttest. The pretest, a printed question sheet, was given before the learning activity to assess baseline ability. The posttest comprised 15 multiple-choice items embedded in the same interactive multimedia that had just taught the material; the system scored responses and reported item correctness immediately. Co-locating instruction and assessment in one product is a design weakness: because the same product delivered both the practice and the test items, the posttest cannot separate content learning from exposure to near-identical items. Appendix A gives the test blueprint mapping each of the 15 items to a learning objective, together with an internal-consistency estimate (Cronbach's $\alpha = 0.85$ across the 15 items) so that reviewers can assess item–content overlap; $\alpha$ indexes consistency, not the exposure confound. As a robustness check against the click-based response format, we also administered a paper-based test after the activity, parallel to the same learning objectives; its results appear under "Changes in Learning Mastery." Future administrations should use an independently developed external test, with documented item specifications and validity evidence, as the primary outcome measure. Learning-outcome categories were excellent (86–100), good (71–85), satisfactory (56–70), poor (40–55), and failed (0–39), and the school's Minimum Mastery Criterion was 75. Analysis used descriptive statistics: percentages, means, category distributions, and changes in mastery attainment from pretest to posttest. Because the design lacked a control group, randomization, and inferential testing, we describe the observed changes as potential effects or indications of preliminary effectiveness, not definitive causal evidence

## Results

### Preliminary Study Findings and Needs Specifications

The preliminary study yielded three findings. *First*, the *Third*-grade Christian Religious Education (CRE) curriculum covers events students cannot directly observe and therefore requires visual and narrative mediation. *Second*, instruction still leans on lectures, textbooks, and static images; films and LCD projectors appear only occasionally. *Third*, infrastructure and use diverge: SD Negeri 41 Kota Gorontalo provides an internet hotspot and a computer laboratory, but has no interactive multimedia that integrates competencies, content, activities, exercises, and evaluation. These findings define the media specifications. The product should engage without being decorative, remain easy for third-graders to navigate, offer concrete examples, include audiovisual content and feedback, permit repetition, and work both online and offline.

Analysis of student characteristics added one further requirement: instruction should scaffold from concrete representation to symbolic explanation. The creation material was therefore designed not as blocks of text but as sequences, images, audio, animations, and simple questions. Learning objectives were rewritten as concrete activities, identifying the order of creation, naming examples of created beings and objects, recognising human diversity, explaining God's omnipotence through biblical figures, expressing gratitude, and showing care for the environment. These specifications formed the basis of the Harmonization stage

**The SAHAT Model Product and Formative Revisions**

The development process produced the SAHAT Model, structured in five stages and nine steps. The Preliminary Study stage set the overall objectives and identified user needs. The Analysis stage examined the alignment of competencies, content, student profiles, and technological systems. The Harmonization stage produced content summaries, a flowchart, a storyboard, and an electronic script. The Application stage delivered the initial prototype and conducted the formative evaluation. The Finalization stage covered revision, field testing, and product completion. This sequence tied every production decision to the learning objectives and the needs-assessment data.

Expert validation judged the prototype suitable for further development after revision. The revisions were structural rather than cosmetic, altering the relationships among media elements: the main menu was reorganized into a clearer learning sequence, the home icon was replaced with one students could recognize, navigation was simplified, visual backgrounds were adjusted to match the subject matter, content and terminology were corrected, and the language was refined. These revisions yielded three prototypes, the *First* for one-to-one evaluation, the *Second* for small-group evaluation, and the *Third* for field testing

**Practicality and Learning Outcomes in the Formative Evaluation**

Table 2.
Summary of Formative Evaluation and Field Testing

| Evaluation Stage | N | Prototype | Practicality | Learning Outcomes | Decision |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| One-to-one evaluation | 3 | 1 | 80.67% (practical) | 100, 93, and 80; mean score of 91 (excellent) | Revision of navigation and visual appearance |
| Small-group evaluation | 3 | 2 | 80.00% (practical) | Mean score of 84 (good) | Improvement of menus, icons, and visual backgrounds |
| Field test | 20 | 3 | 84% (practical) | 100% mastery; 95% above the Minimum Mastery Criterion | Final product and indication of a potential effect |

In the one-to-one evaluation, the three students gave the prototype a mean practicality rating of 80.67% (practical), and their posttest scores were 100, 93, and 80 (mean = 91). Learning outcomes were high, but observation revealed friction in navigation and visual layout. These findings guided revisions to the menu sequence, buttons, and instruction wording before the small-group round.

In the small-group round, the revised prototype received a practicality rating of 80.00% (practical) and a mean learning-outcome score of 84. Students navigated the material, understood it, and completed the exercises, though several menu elements and background visuals still needed refinement. The small-group setting exposed problems that individual use had hidden: students waited for one another, copied one another's choices, and needed clearer screen-to-screen sequencing.

In the field test, the practicality observation score reached 84.00% (practical). Students most consistently followed instructions, showed interest, worked with enthusiasm, understood the material, and completed the exercises. Asking questions and voicing opinions, by contrast, still depended on teacher prompting. The product was easy to use, but verbal classroom interaction still required the teacher's direction

**Changes in Learning Mastery During the Field Test**

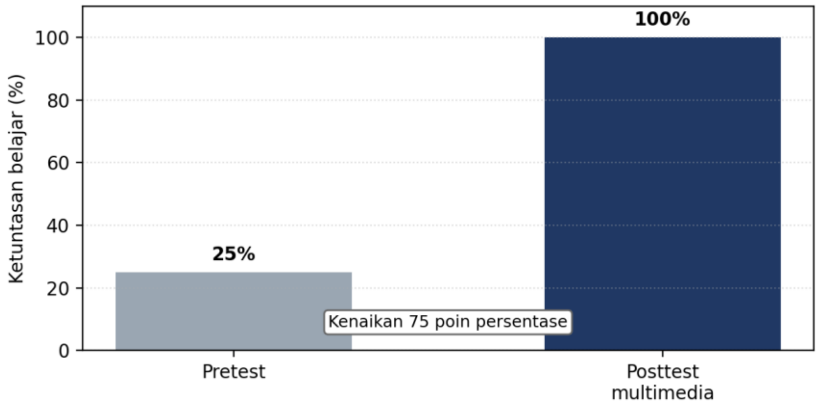
On the initial test, 25% of students (5 of 20) met the Minimum Mastery Criterion and 75% did not. After the interactive-multimedia lesson, all 20 met the criterion on the immediate posttest, a 75-percentage-point gain. Nine students scored between 93 and 100, ten scored 80, and one scored 75 (the threshold); 19 of 20 (95%) therefore scored strictly above the criterion. The cluster of ten identical scores of 80 on a short test with few items points to a ceiling effect and low sensitivity to individual differences.

These changes are reported descriptively, not causally. A single-group, immediate-posttest design carries at least six threats to internal validity: practice and testing of embedded items; history (including teacher and researcher presence, with a possible

Hawthorne effect); maturation; regression to the mean from a low baseline; instrumentation; and selection of a single intact class (Shadish, Cook, & Campbell, 2002).

A separate paper-based test given after the activity showed the same pattern: 17 students were rated "very good" and 3 "good." This partly addresses the worry that scores reflect the app's click-based format rather than learning, but it does not remove the testing-effect threat, because the paper test followed the activity with no delay. Without a control group or a delayed posttest, these results cannot separate any multimedia effect from repetition, teacher support, item similarity, short-lived motivation, or other classroom factors.

Figure 2.
Changes in the Percentage of Learning Mastery from Pretest to Posttest




## Synthesis of the Main Findings

We identified four principal findings. *First*, technological devices alone cannot meet instructional needs; a blueprint must integrate objectives, content, student characteristics, and technology. *Second*, the SAHAT Model produced a development sequence that traced clearly from needs-assessment data to the final product. *Third*, the multilevel formative evaluation surfaced distinct problems at each stage: experts checked accuracy and design; the one-to-one evaluation revealed friction points for individual users; the small-group evaluation examined simultaneous use; and the field test assessed classroom implementation. Fourth, the product met the practicality criterion, and mastery scores rose within the single cohort tested. Because this is the weakest quasi-experimental design,[22] we read this as a feasibility signal, the product is promising and warrants further

[22] William R Shadish, Thomas D Cook, and Donald T Campbell, *Experimental and Quasi-Experimental Designs for Generalized Causal Inference* (Boston: Houghton Mifflin, 2002).

testing, not as evidence of effectiveness. Therefore, we do not present the 25%–100% figure as a headline result.

## Discussion

### Harmonization as the Core Contribution of the SAHAT Model

The findings show that SAHAT operationalizes a stage already present in ADDIE rather than adding a new one. In media-development practice, teams often move to applications, animations, or templates before deciding what pupils must understand and how they will get there. ADDIE's Design phase is meant to prevent this, but non-designer teachers often find it underspecified.[23] SAHAT's Harmonization stage makes that phase concrete and enforceable. Teachers summarize objectives and key content *First*, map the cognitive flow in a flowchart, and specify each screen in a storyboard. They then choose images, audio, video, text, and buttons on instructional grounds, not aesthetic ones. The claim is therefore modest and defensible: SAHAT introduces no ontological novelty. It turns the ADDIE Design phase into required, reviewable artifacts that teachers can produce and experts can check (Table 3). Whether teachers produce these artifacts more easily than they work through ADDIE's generic Design phase is a usability question this study did not test; future work should examine it directly with non-designer teachers.

Table 3.
Design-Phase Activities in ADDIE and Their Explicit Operationalization in the SAHAT Harmonization Stage

| **ADDIE Design-phase output Branch, 2009** | **SAHAT Harmonization: required, reviewable artifact for non-designer teachers** |
|---|---|
| Concept map/content analysis | An objective-to-content map that links each learning objective to specific content and to the screen where it appears |
| Learning-task and objective analysis | An objective-to-activity alignment matrix that is checked before any production begins |
| Storyboard | A storyboard treated as a formal sign-off gate, reviewed by instructional-design, content, multimedia, and language experts |
| Media and navigation specification | A flowchart of the cognitive and navigation flow, produced and reviewed before assets are built |
| Evaluation planning | An electronic script plus a formative-evaluation blueprint (expert review, one-to-one, small-group, field test) fixed before prototyping |

This stage aligns with the argument that multimedia benefits depend on integration quality, not on the number of modalities used. Mayer identifies selection, organization, and integration as the core processes of meaningful learning.[24] Noetel et al. meta-

[23] Branch and Varank, *Instructional Design: The ADDIE Approach*.
[24] Mayer, "The Past, Present, and Future of the Cognitive Theory of Multimedia Learning."

analytically confirmed the effectiveness of signaling, contiguity, segmenting, coherence, and redundancy management,[25] and the redundancy effect itself depends on which type of redundant information is present.[26] Meta-analytic evidence on signaling specifically confirms its role in directing attention toward relevant information.[27] This finding also extends to elementary learners, for whom different textual cues in animations affect both learning outcomes and cognitive load.[28] Within the SAHAT Model, flowcharts and storyboards allow these principles to be checked before production begins: whether text sits close to the corresponding image, whether content sequences run too long, whether audio repeats written text, and whether visual cues direct students' attention. Harmonization can thus be read as a design-level mechanism for managing cognitive load and safeguarding content accuracy. This is a theoretical rationale, not an empirical claim: cognitive load was not measured in this study. Future work should include validated load measures, such as Paas-type single-item ratings or child-adapted NASA-TLX scales, before asserting that any specific principle reduced extraneous load or increased germane load.[29]

Harmonization also matters because CRE content is not representationally neutral. Visualizations of creation, biblical figures, or human diversity must appeal to children while remaining appropriate and avoiding misleading theological impressions. The revisions to visual backgrounds and content in this study show that expert validation is needed to balance aesthetics, pedagogy, and religious sensitivity. In other fields, visual inaccuracies may interfere with conceptual understanding; in religious education, inappropriate representations may distort the meaning of values and beliefs. The

[25] Noetel et al., "Multimedia Design for Learning: An Overview of Reviews With Meta-Meta-Analysis."
[26] F Albers et al., "Different Types of Redundancy and Their Effect on Learning and Cognitive Load," *British Journal of Educational Psychology* 93, no. S2 (2023): 339–52, https://doi.org/10.1111/bjep.12592.
[27] D Alpizar, O O Adesope, and R M Wong, "A Meta-Analysis of Signaling Principles in Multimedia Learning Environments," *Educational Technology Research and Development* 68, no. 5 (2020): 2095–2119, https://doi.org/10.1007/s11423-020-09748-7.
[28] L Du, X Tang, and J Wang, "Different Types of Textual Cues in Educational Animations: Effect on Science Learning Outcomes, Cognitive Load, and Self-Efficacy among Elementary Students," *Education and Information Technologies* 30, no. 3 (2025): 3573–96, https://doi.org/10.1007/s10639-024-12929-z.
[29] F Paas et al., "Cognitive Load Measurement as a Means to Advance Cognitive Load Theory," *Educational Psychologist* 38, no. 1 (2003): 63–71, https://doi.org/10.1207/S15326985EP3801_8; John Sweller, "Cognitive Load Theory," in *Psychology of Learning and Motivation*, ed. Jose P Mestre and Brian H Ross, vol. 55 (San Diego, CA: Elsevier Academic Press, 2011), 37–76, https://doi.org/10.1016/B978-0-12-387691-1.00002-8.

combination of subject-matter, instructional-design, multimedia, and language experts is therefore a genuine strength of the development process.

Methodologically, the Harmonization stage supports teachers who are not professional developers. Generic models often stop at the word "design" without specifying what artifacts must be produced. The SAHAT Model makes these outputs concrete: key content points, flowcharts, storyboards, electronic scripts, and evaluation instruments. Cavanagh and Kiersch show that usable multimedia lessons can be built with commonly available technologies when design follows the cognitive theory of multimedia learning; this supports the plausibility of teacher-led development.[30] These artifacts reduce dependence on intuition and enable collaboration among teachers, subject-matter experts, illustrators, and programmers. The model's contribution is both procedural and translational: it converts instructional-design knowledge into operational steps that schools can carry out.

**From Usability to Classroom Orchestration**

The practicality scores of 80.67% (one-to-one), 80.00% (small-group), and 84.00% (field test) indicate that most students could follow instructions, understand menus, complete exercises, and sustain attention. Media for *Third*-grade students must minimize the operational cost of use. When students spend cognitive capacity locating buttons or parsing instructions, the resources that should serve learning are consumed by the interface. The navigation and home-icon revisions confirm that usability is integral to instructional design, not peripheral to it.

Practicality, however, extends beyond whether students can click. The observation data showed that asking questions and expressing opinions did not increase simply because interactive media were available. This reinforces the distinction between functional interactivity and cognitive-social interactivity. Buttons, menus, and feedback create opportunities for interaction, but teachers must still pose open-ended questions, ask students to explain their reasoning, connect images with experience, and facilitate value-based reflection. Cromley and Chen found that active-learning interventions produced

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[30] T M Cavanagh and C Kiersch, "Using Commonly-Available Technologies to Create Online Multimedia Lessons through the Application of the Cognitive Theory of Multimedia Learning," *Educational Technology Research and Development* 71, no. 3 (2023): 1033–53, https://doi.org/10.1007/s11423-022-10181-1.

stronger effects than surface-level design modifications,[31] and evidence on interactive learning environments similarly ties gains to how the interaction is structured rather than to interactivity as such.[32] Even the best multimedia must be orchestrated as a learning activity, not presented as something to be watched.

Practicality should therefore be evaluated at two levels. The *First* is usability: readability, button consistency, response time, instruction clarity, and the ability to repeat content. The *Second* is orchestration fit: the ease with which teachers can pause the media, start discussion, organize groups, provide assistance, and connect digital activities with prayer, stories, and concrete actions. This study measured the first level and partly addressed the *Second* through classroom observation. Future instruments should assess teacher workload, transition time, discussion quality, and variation across individual and group use.

Cross-device flexibility adds contextual value. The product runs on computers, laptops, tablets, or smartphones, online or offline. This flexibility matters for schools where connectivity fluctuates. Yet technical flexibility should not obscure access equity. Di Pietro and Castaño Muñoz showed that structured computer-assisted instruction benefits learners more than access to devices alone. Implementation strategies should not assume every student owns a personal device. Schools can use projectors, computer laboratories, learning stations, or group arrangements that still give all students opportunities to respond.[33]

**Why Did Learning Outcomes Improve?**

The within-group mastery gain can be read against cognitive theory, though only as interpretation. At least five mechanisms may have contributed. *First*, the combination of words and images may have helped pupils build complementary verbal and visual representations. *Second*, animations and videos may have turned abstract event sequences into observable processes. *Third*, menu segmentation may have let pupils process material in smaller units. *Fourth*, exercises and immediate feedback may have strengthened

[31] Cromley and Chen, "A Meta-Analysis of Richard Mayer's Multimedia Learning Research: Searching for Boundary Conditions of Design Principles across Multiple Media Types."

[32] U Tugtekin and H F Odabasi, "Do Interactive Learning Environments Affect Learning Outcomes, Cognitive Load, and Metacognitive Judgments?," *Education and Information Technologies* 27, no. 5 (2022): 7019–58, https://doi.org/10.1007/s10639-022-10912-0.

[33] Di Pietro and Castaño Muñoz, "A Meta-Analysis on the Effect of Technology on the Achievement of Less Advantaged Students."

retrieval and corrected errors. *Fifth*, learner-controlled navigation may have supported repetition at each pupil's own pace. These mechanisms align with the Cognitive Theory of Multimedia Learning and with meta-analytic findings on signaling, coherence, testing, scaffolding, and text-diagram integration.[34] The present design cannot distinguish among these mechanisms because no condition isolates any single one; the five are offered as post hoc interpretations, not as tested claims.

The improvement may also reflect developmental appropriateness. The creation material progressed from concrete experiences (images of nature, the sequence of days, sounds, movements, environmental examples) to abstract terms and explanations. Concrete representations do not reduce theology to images; they provide anchors that help children organize knowledge. When students sequenced, selected, named, and connected representations with environmentally responsible actions, the learning process moved from passive listening to active information processing.

Motivation may also mediate the effect. Aseery reported that digital storytelling, animation, audio, practical activities, and positive feedback can raise elementary students' engagement in religious education.[35] Gamified activities have shown similar engagement gains in elementary classrooms.[36] The SAHAT Model product integrated several of these elements. Visual attractiveness and instrumental music may have captured initial attention, while questions and feedback sustained engagement. Attention, however, is not identical to learning. The product's effect is more plausibly explained by the combination of engagement, content structure, practice, and feedback than by entertainment alone.

Evidence from other contexts supports this reading. Dong et al., found that interactive visual multimedia improved children's literacy in rural areas.[37] Similarly, interactive multimedia e-modules have been linked to better outcomes and favorable

[34] Mayer, "The Past, Present, and Future of the Cognitive Theory of Multimedia Learning"; Cromley and Chen, "A Meta-Analysis of Richard Mayer's Multimedia Learning Research: Searching for Boundary Conditions of Design Principles across Multiple Media Types"; Noetel et al., "Multimedia Design for Learning: An Overview of Reviews With Meta-Meta-Analysis."
[35] Aseery, "Enhancing Learners' Motivation and Engagement in Elementary Religious Education Classes."
[36] B Rayan and A Watted, "Enhancing Education in Elementary Schools through Gamified Learning: Exploring the Impact of Kahoot! On the Learning Process," *Education Sciences* 14, no. 3 (2024): 277, https://doi.org/10.3390/educsci14030277.
[37] Dong et al., "The Effectiveness of Using Interactive Visual Multimedia Technology Intervention in Improving the Literacy Skills of Children in Rural China."

student responses in elementary schools.[38] Adaptive, game-based applications that personalize practice have improved early elementary learning.[39] Dong et al., found that interactive multimedia was the dominant format in elementary-school research and was generally associated with higher motivation and better learning outcomes.[40] Daryanes et al., showed that developing interactive media through the ADDIE sequence could produce a highly valid product and support problem-solving abilities.[41] The common feature across these studies is that the media were designed around objectives and activities, not around converting textbooks into digital screens.

The magnitude of the change must, however, be interpreted with caution. *First*, the low baseline left considerable room for improvement. *Second*, the immediate posttest made short-term memory effects likely. *Third*, no comparison group received the same content and instructional time without multimedia. Fourth, the teacher and researcher may have provided more intensive support during the field test than would occur in routine classroom use. Fifth, the embedded questions may have been closely aligned with the material just studied. "Potential effect," as used in this study, is therefore a more accurate characterization than "causal effectiveness". These findings constitute preliminary evidence of feasibility and promise, not a generalizable effect-size estimate

**Contributions to CRE Multimedia Development**

The SAHAT Model extends CRE multimedia development in three ways. *First*, it shifts attention from devices to learning experiences. Hardware is interchangeable: the product runs on a computer, tablet, or smartphone. What must remain constant are the objectives, sequence, representations, activities, and feedback. *Second*, it links content validity to user experience. Expert review verifies accuracy and feasibility; one-to-one and small-group trials test whether the design is intelligible to children. *Third*, it treats revision as an ongoing process, not an administrative step taken once the product is judged complete.

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[38] Alyusfitri et al., "The Effectiveness and Relationship of Student Responses toward Learning Outcomes Using Interactive Multimedia-Based e-Modules in Elementary Schools."
[39] H J Bang, L Li, and K Flynn, "Efficacy of an Adaptive Game-Based Math Learning App to Support Personalized Learning and Improve Early Elementary School Students' Learning," *Early Childhood Education Journal* 51, no. 4 (2023): 717–32, https://doi.org/10.1007/s10643-022-01332-3.
[40] Aryfien, Atmojo, and Matsuri, "Interactive Learning Media for Better Learning Outcomes in Elementary School: A Systematic Literature Review."
[41] Daryanes et al., "The Development of an Articulate Storyline and Interactive Learning Media Based on Case Methods to Train Students' Problem-Solving Ability."

The model can be extended to other CRE topics, such as love for others, forgiveness, honesty, responsibility, and ecological care. It cannot, however, be transferred by copying its visual surface. Each topic calls for its own analysis of the abstraction involved, the misconceptions likely to arise, the narrative form that fits, and the activities that suit it. Value-related content, for example, works better with decision-making scenarios, reflection, role play, or action projects than with multiple-choice items alone. The SAHAT Model is best understood as a flexible process architecture, not a rigid screen template.

The product can also support blended learning. Students can access sections before class, use the media with the teacher during instruction, and complete a reflection or project afterward. Blended design, however, must manage task load and parental involvement with care. For *Third*-grade students, fully independent learning is not yet appropriate: instructions must be short, access safe, data collection minimal, and screen time controlled. Multimedia should enrich students' interactions with teachers, peers, families, and their environment, not replace them.

The approach also has implications for teacher professional development. Aryfien et al., noted that teachers' digital competence is central to the success of interactive media.[42] The SAHAT Model can guide project-based training: teachers select one competency, conduct a simple needs assessment, draft a flowchart and storyboard, build a prototype with available tools, and test it with several students. This is more productive than application-based training that teaches technical features without addressing instructional design

**Limitations and Future Research**

The study has several limitations. *First*, the field test involved only 20 students from one school; variation in school background, digital competence, classroom culture, and facilities was therefore not represented. *Second*, both the one-to-one and small-group formative stages used a micro-sample of three pupils, below the range Tessmer recommends, which weakens the distinction between individual and group use. *Third*, the one-group pretest–posttest design, without a control group, could not isolate the

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[42] Aryfien, Atmojo, and Matsuri, "Interactive Learning Media for Better Learning Outcomes in Elementary School: A Systematic Literature Review."

multimedia effect.[43] *Fourth*, the analysis was descriptive: it did not include inferential tests, effect sizes, or confidence intervals. An internal-consistency estimate is reported (Cronbach's α = 0.85), but a single observer conducted all observations, so inter-rater reliability was not established. *Fifth*, the immediate posttest did not address retention or transfer. Sixth, the findings addressed cognitive outcomes and user activities but did not capture attitudes, spiritual reflection, or action, all of which fall within CRE objectives. Seventh, consent was obtained orally and the study relied on institutional permissions rather than formal ethics-committee review; future studies should strengthen this.

Future studies should use quasi-experimental or randomized controlled trial designs with comparison groups receiving teacher-led instruction of equivalent content and duration. Measurements should include a pretest, immediate posttest, delayed posttest, and transfer tasks. Engagement instruments could distinguish behavioral, emotional, cognitive, and agentic dimensions. Beyond posttest scores, researchers could analyze interaction logs, time per screen, repetition patterns, error types, oral-explanation quality, and environmentally responsible action projects. Multilevel analysis is warranted once designs cross multiple classrooms and schools. To move beyond a generic wish list, future protocols should specify an a priori power analysis for minimum sample size, a treatment-fidelity check, covariate adjustment for prior CRE achievement and digital literacy, and, where feasible, instructor blinding (pupil blinding is not possible).

Future designs should also examine multimedia principles at a finer grain. Experiments could compare versions with and without signaling, audio-narration versions with minimal on-screen text, or learner-controlled versus system-controlled segmentation. Cromley and Chen showed that multimedia effects vary by learning-outcome type and participant characteristics.[44] Evaluation should therefore ask not only whether a product works, but which elements work, for whom, and for which outcomes. A component-analysis approach would move the SAHAT Model from a procedural framework toward an evidence-based one.

Ethical and inclusive design also needs strengthening. The product should provide alternative text or narration for students with special needs, adequate font sizes and

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[43] Tessmer, *Planning and Conducting Formative Evaluations: Improving the Quality of Education and Training*.
[44] Cromley and Chen, "A Meta-Analysis of Richard Mayer's Multimedia Learning Research: Searching for Boundary Conditions of Design Principles across Multiple Media Types."

contrast, audio controls, and pacing that does not rely on reading speed. Representations of ethnic groups, cultures, and social conditions should be inclusive. Because religious materials are closely tied to identity and values, feasibility evaluation should involve teachers, subject-matter experts, parents, school-community members, and students in balanced proportions.

**Practical Implications**

Table 4.
Implications for the Implementation of the SAHAT Model

| Stakeholder | Priority Actions | Indicators of Success |
|---|---|---|
| CRE teachers | Begin with one competency; develop a flowchart and storyboard; use the media for questions and answers, prediction, practice, and reflection. | Students do not merely watch but explain, select, repeat, and connect the material with concrete actions. |
| Schools | Provide shared access, technical support, trial time, and interteacher review forums; do not make personal-device ownership a prerequisite. | The media are used according to a schedule, can operate offline, and do not widen inequalities in access. |
| Developers | Apply signaling, coherence, segmenting, consistent navigation, informative feedback, and one-to-one testing before the field test. | Major problems are identified before final production, and revisions are documented and traceable. |
| Researchers | Use comparison groups, retention and transfer measurements, and analyses of engagement and usage logs. | Conclusions can distinguish usability, engagement, learning, retention, and attitudinal changes. |

At the implementation level, the SAHAT Model is most appropriately used as a collaborative process that begins with an authentic problem. Teachers do not need to produce complex applications. Simple interactive presentations, branching videos, quizzes with feedback, or locally developed modules can become effective products when supported by strong analysis and harmonization. The principal requirement is that every media element must address a specific learning need, every stage must produce an artifact that can be reviewed, and every prototype must be tested with users before it is established as the final product.

**Conclusion**

This study developed the SAHAT Model, a development framework for interactive multimedia in Christian Religious Education (CRE). The model consists of five stages and nine steps: Preliminary Study, Analysis, Harmonization, Application, and Finalization. It integrates the systems orientation of ADDIE, the production orientation of the Pustekkom model, and a learning sequence progressing from concrete to symbolic experiences. Its main contribution is the Harmonization stage. Harmonization operationalizes the ADDIE Design phase by aligning learning objectives, content, student characteristics, technology, flowcharts, storyboards, navigation, and evaluation into required, reviewable artifacts before production begins.

The product was declared feasible after expert validation and iterative revisions. User evaluations produced practicality scores of 80.67% at the one-to-one stage, 80.00% at the small-group stage, and 84.00% in the field test. Learning mastery rose from 25% to 100%: 95% of students scored above the Minimum Mastery Criterion and one at the criterion itself. These findings indicate that multimedia developed through the SAHAT Model is a promising prototype, and the model a candidate framework, for making CRE instruction more concrete and structured. It is not described here as "engaging," because engagement was not measured with a dedicated instrument covering behavioral, emotional, cognitive, and agentic dimensions. Consistent with a feasibility study, the change in mastery is interpreted only as a potential effect, given the absence of a control group, an adequate sample size, inferential analysis, and a retention measure. The claim that the model offers an easier operational pathway for non-designer teachers is likewise proposed rather than demonstrated, since the Harmonization artifacts were not tested with teachers as end users.

The SAHAT Model warrants further study across multiple schools, denominations, and subject areas before broader applicability can be claimed. Future replications should strengthen data integrity, test individual design components separately, assess retention and transfer, measure attitudinal and behavioral dimensions, and evaluate whether teachers can apply the model more easily than existing alternatives. At present, it is a context-specific, feasibility-stage framework.

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